Contents lists available at ScienceDirect

Journal of the Formosan Medical Association

Journal homepage: http://www.jfma-online.com

Original Article

Self-efficacy Affects Blood Sugar Control Among Adolescents With Type I Diabetes Mellitus

*An-Hsuan Chih,[1] Chyi-Feng Jan,[1] San-Ging Shu,[2] Bee-Horng Lue[1,3]**

Background/Purpose: Self-management is crucial to diabetes control. To investigate the effectiveness of self-management in reaching target hemoglobin A1c (HbA1c) level, we conducted a study among Taiwanese adolescents with type 1 diabetes mellitus (DM).
Methods: Patients aged 12–20 years with type 1 DM participated in an annual integrated DM care clinic at a medical center in Taiwan. All patients completed a questionnaire that included demographic data and self-efficacy measured by the Perceived Diabetes Self-Management Scale (PDSMS) in February 2008. Laboratory tests were also done at the same visit. The target HbA1c was $<7.0\%$ in accordance with the general standard of the American Diabetes Association for patients with type 1 DM. Logistic regression analysis was used to explore the relationship between age, sex, duration of diabetes, PDSMS score, and HbA1c level.
Results: Fifty-two patients were enrolled. The mean age was 16.0 ± 2.4 years, and mean HbA1c level was $8.6 \pm 1.6\%$. Pearson correlation analysis showed a positive correlation between body mass index and preprandial blood sugar level ($r = 0.297$, $p < 0.05$). Negative correlations were found between PDSMS scores and duration of diabetes ($r = -0.365$, $p < 0.01$) as well as HbA1c level ($r = -0.295$, $p < 0.05$). Logistic regression analysis demonstrated that sex and PDSMS scores significantly influenced glycemic control. In multivariate logistic regression analysis, patients with higher PDSMS scores were 1.63 times (95% confidence interval = 1.03–2.59) more likely to reach target diabetes control after adjustment for other variables. Male patients also had a higher probability (odds ratio = 19.80, 95% confidence interval = 1.34–291.93) of reaching target diabetes control.
Conclusion: This study demonstrates that adolescents with type 1 DM and higher self-efficacy, especially males, have a higher probability of reaching target diabetes control.

Key Words: adolescents, blood sugar, hemoglobin A1c, self-efficacy, type 1 diabetes mellitus

[1]Department of Family Medicine, National Taiwan University Hospital, [3]Department of Social Medicine, College of Medicine, National Taiwan University, Taipei, and [2]Department of Pediatric Endocrinology, Taichung Veterans General Hospital, Taichung, Taiwan.

Received: March 2, 2009
Revised: November 26, 2009
Accepted: December 1, 2009

***Correspondence to:** Dr Bee-Horng Lue, Department of Family Medicine, National Taiwan University Hospital, National Taiwan University, 7 Chung San South Road, Taipei 100, Taiwan.
E-mail: grace@ntu.edu.tw

Type 1 diabetes mellitus (DM) is caused by destruction of pancreatic β cells via cell-mediated autoimmunity or other causes.[1] It usually occurs in childhood or adolescence. Patients need regular insulin injection if the diagnosis is confirmed. Intensive insulin treatment to reach the target glycemic control has been proven to be effective in delaying the progression of diabetic retinopathy, nephropathy and neuropathy in patients with type 1 DM.[2] Among these type 1 DM patients, adolescents usually have poorer adherence to medications and worse metabolic control than preadolescent children.[3] Adolescents are at the developmental stage of struggling for their autonomy. They are more likely to manage their diabetes according to their personal opinion rather than that of their parents.[4] This personal opinion might result in lower adherence to the prescribed treatment regimen and thus worsen their metabolic control. In addition, adolescents have more opportunities than children to adopt avoidance coping behavior when they are facing chronic diseases. Avoidance behavior is known to be significantly associated with poorer adaptation and glycemic control.[3] The above behavior of adolescents makes it necessary to identify factors that lead to good diabetes control, to reduce long-term complications.

Data from The Bureau of National Health Insurance, Taiwan have shown that the annual incidence of type 1 DM among Taiwanese children and adolescents aged < 15 years was 3.75 per 100,000 in 1992–1996,[5] which was lower than that reported in western countries.[6] Consciousness disturbance is often presented as the initial manifestation of life-threatening diabetic ketoacidosis in Taiwanese children and adolescents.[7] Among the factors that affect glycemic control in adolescents, self-efficacy,[8] family involvement,[9] and participation in coping skills training[10] are all highly related to good control of type 1 DM. Self-efficacy is defined as one's confidence to take action to achieve a specific goal.[11] It plays an important role in health behavior among adolescents and children.[12] Furthermore, diabetic patients have better quality of life if they have strong beliefs in their self-efficacy.[13] For patients with type 1 DM, self-efficacy is particularly crucial due to a lot of self-management tasks that they need to perform to control their chronic disease. These tasks include daily insulin injections, self-monitoring of blood glucose, regular exercise, as well as a balanced diet.[14] Adolescents with diabetes are prone to avoidance when given increasing responsibility for the management of their chronic illness, therefore, the factor of self-efficacy is worthy of investigation.

This study aimed to elucidate the relationship between self-efficacy and target glycemic control among Taiwanese adolescents with type 1 DM.

Materials and Methods

Study design

We conducted a cross-sectional study to investigate the influence of self-efficacy on the ability of Taiwanese adolescents with type 1 DM to reach target hemoglobin A1c (HbA1c) level.

Study subjects

Our study subjects were recruited from patients aged 12–20 years with type 1 DM from a medical center in Central Taiwan. The Institutional Review Board of Taichung Veterans General Hospital approved this study, and oral informed consent was obtained from all participating subjects. The research was performed when the subjects participated in an annual integrated DM care clinic in February 2008. Subjects without HbA1c data or who had been newly diagnosed with type 1 DM within 12 months were excluded.

Questionnaire

All patients were asked to complete a self-report questionnaire that included basic demographic data and self-efficacy measure by the Perceived Diabetes Self-Management Scale (PDSMS) developed by Wallston et al.[15] The translation and administration of PDSMS were carried out with permission from Dr Kenneth A. Wallstone. All data collected were confidential. The basic data consisted of age, sex, educational level, and experiences of hospitalization or emergency visits related to diabetes in the past year. The PDSMS comprised eight items to measure patients' confidence in managing their glycemic control well (the so-called self-efficacy). The responses to the items were rated on a five-point Likert-type scale, which ranged from 1 (strongly disagree) to 5 (strongly agree). Four of the eight items were reverse-scored because "strongly agree" in these items reflected low perceived competence. The final PDSMS scores ranged from 8 to 40, with higher scores signifying greater confidence in self-managing diabetes. Cronbach's α was 0.834 in the original study,[15] and 0.802 in this study.

Laboratory tests

Preprandial blood sugar, triglyceride and HbA1c levels were checked. HbA1c level was detected using affinity high-performance liquid chromatography (Primus CLC 385; Primus, Kansas City, MO, USA). Blood sugar control was determined by measuring HbA1c data.[16] The Diabetes Control and Complications Trial and the succeeding Epidemiology of Diabetes Interventions and Complications study have suggested that a practical target HbA1c level is $\leq 7\%$.[17] Besides, the ideal target blood glucose level in children and adolescents is generally the same as for adults.[18] Although the American Diabetes Association has recommended a less strict standard ($<7.5\%$) for adolescents and young adults aged 13–19 years, it has still emphasized that a goal of $<7\%$ is reasonable if it can be achieved without hypoglycemia.[19] To clarify the connection between self-efficacy and tight glycemic control, we adopted HbA1c $<7\%$ as representing good diabetes control in our study.

Statistical analysis

Statistical analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Pearson correlation analysis was performed to evaluate associations between any two of the variables among age, duration of diabetes, preprandial blood sugar level, HbA1c level, triglyceride level, body mass index (BMI), and PDSMS scores. By treating HbA1c level $<7\%$ as a dependent variable, univariate and multivariate logistic regression analyses were performed to examine the relationship between target glycemic control and PDSMS scores after adjustment for age, sex and duration of diabetes. The odds ratio (OR) and 95% confidence interval (CI) were calculated. Statistical significance was set at $p<0.05$.

Results

Initially, 77 patients were recruited in this annual follow-up. Among them, 31 were male (40.3%) and 46 were female (59.7%). Twenty-one patients were excluded because their ages were out of our target range of 12–20 years. Two patients were excluded because they had been diagnosed with type 1 DM within the previous year. Another two patients were excluded because of a lack of HbA1c data. Finally, a total of 52 patients were enrolled: 18 male (34.6%) and 34 female (65.4%), with a mean age of 16.0 ± 2.4 years. Their educational levels ranged from junior high school ($n=26$; 50%) to senior high school/vocational high school ($n=13$; 25%), and university ($n=13$; 25%). The average duration of diabetes was 7.9 ± 4.3 years, and the mean HbA1c level was $8.6 \pm 1.6\%$. Seven patients (13.5%) were noted to reach the target HbA1c level of $<7\%$. All patients injected insulin by themselves, and six patients (11.5%) were admitted to a hospital or emergency department owing to acute complications of diabetes in the previous year. The PDSMS scores of male and female subjects were 25.7 ± 4.1 and 25.8 ± 4.6, respectively. The demographic and laboratory data between male and female patients did not demonstrate any significant differences by Mann–Whitney *U* test (Table 1). Also, there was no significant educational difference between male and female patients using the Pearson χ^2 test ($p=0.601$).

In Pearson correlation analysis, age and duration of diabetes were not associated with HbA1c level. There was a positive correlation between age and duration of diabetes ($r=0.388$, $p<0.01$). A positive correlation was found between BMI

Table 1. Comparison of demographic and laboratory data of the patients ($n = 52$)

	Total ($n = 52$)	Male ($n = 18$)	Female ($n = 34$)	p*
Mean age (yr)	16.0 ± 2.4	15.6 ± 2.5	16.2 ± 2.3	0.40
Duration of diabetes (yr)	7.9 ± 4.3	8.4 ± 4.5	7.7 ± 4.3	0.64
Mean triglyceride level (mg/dL)	68.5 ± 53.4	57.4 ± 14.9	74.4 ± 64.8	0.86
Mean AC (mg/dL)	180.1 ± 79.2	159.6 ± 71.5	191.3 ± 81.9	0.15
Mean HbA1c level (%)	8.6 ± 1.6	8.0 ± 1.5	8.8 ± 1.7	0.06
Mean systolic pressure (mmHg)	121.4 ± 11.8	124.4 ± 13.4	120.0 ± 10.9	0.21
Mean diastolic pressure (mmHg)	74.5 ± 9.3	76.3 ± 9.7	73.7 ± 9.1	0.28
BMI (kg/m^2)	21.6 ± 3.6	20.5 ± 3.4	22.2 ± 3.7	0.09
PDSMS scores	25.7 ± 4.4	25.7 ± 4.1	25.8 ± 4.6	0.76
Insulin self-injection (n)	52	18	34	
ER visits/admission last year (n)	6	0	6	0.08†

Mann–Whitney U test; †Fisher exact test. AC = preprandial sugar level after 8 hours of fasting; BMI = body mass index; PDSMS = Perceived Diabetes Self-Management Scale; ER = emergency room.

Table 2. Pearson correlation of different variables

	Age	Duration of diabetes	AC sugar level	HbA1c level	Triglyceride level	BMI	PDSMS scores
Age	1						
Duration of diabetes	0.388†	1					
AC	0.073	0.036	1				
HbA1c level	0.075	–0.092	0.065	1			
Triglyceride level	–0.171	0.057	0.152	0.236	1		
BMI	0.249	0.054	0.297*	0.171	0.037	1	
PDSMS scores	–0.033	–0.365†	–0.088	–0.295*	–0.174	–0.177	1

$p < 0.05$; †$p < 0.01$. AC = preprandial sugar level after 8 hours of fasting; BMI = body mass index; PDSMS = Perceived Diabetes Self-Management Scale.

and preprandial blood sugar level ($r = 0.297$, $p < 0.05$). The PDSMS scores showed a negative correlation with duration of diabetes ($r = –0.365$, $p < 0.01$). The PDSMS scores were not correlated significantly with preprandial blood sugar level, triglyceride level and BMI, but they were negatively correlated with HbA1c level ($r = –0.295$, $p < 0.05$) (Table 2). The scatter plot between HbA1c level and PDSMS scores is illustrated in the Figure. The trend line of linear regression in the Figure indicated that higher PDSMS scores (better self-efficacy) were significantly associated with lower HbA1c level (better glycemic control).

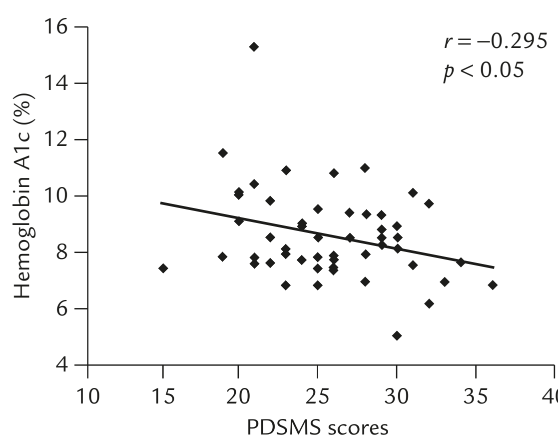

Figure. Linear regression plot between hemoglobin A1c level and Perceived Diabetes Self-Management Scale scores.

Univariate logistic regression analysis demonstrated that higher PDSMS scores and male sex significantly predicted reaching the target HbA1c level. The OR for PDSMS scores and male sex were 1.32 (95% CI = 1.04–1.66) and 6.15 (95% CI = 1.06–35.84), respectively (Table 3). In multivariate logistic regression analysis, patients with higher PDSMS scores were 1.63 times (95% CI = 1.03–2.59) more likely to reach target

Table 3. Univariate logistic regression analysis to evaluate the association between glycemic control and different predictors*

Predictors (Variables)	Category	Crude OR (95% CI)	*p*
Age	Continuous	1.04 (0.75–1.46)	0.812
Gender	Male = 1 Female = 0	6.15 (1.06–35.84)	0.043†
Duration of diabetes	Continuous	0.96 (0.79–1.16)	0.661
AC	Continuous	0.99 (0.98–1.00)	0.129
Triglyceride	Continuous	0.97 (0.93–1.02)	0.198
BMI	Continuous	0.81 (0.58–1.12)	0.196
ER visits/admission last year	Yes = 1 No = 0	–	0.999
PDSMS scores	Continuous	1.32 (1.04–1.66)	0.022†

**Treat glycemic control as outcome variable; †$p < 0.05$ by logistic regression. OR = odds ratio; CI = confidence interval; AC = preprandial sugar level after 8 hours of fasting; BMI = body mass index; ER = emergency room; PDSMS = Perceived Diabetes Self-Management Scale.*

Table 4. Multivariate logistic regression to evaluate the association between glycemic control and PDSMS scores*

Predictors (Variables)	Category	Adjusted OR (95% CI)	*p*
Age	Continuous	0.97 (0.63–1.49)	0.875
Gender	Male = 1 Female = 0	19.80 (1.34–291.93)	0.030†
Duration of diabetes	Continuous	1.07 (0.79–1.44)	0.664
PDSMS scores	Continuous	1.63 (1.03–2.59)	0.038†

**Treat glycemic control as outcome variable; †$p < 0.05$ by logistic regression. OR = odds ratio; CI = confidence interval; PDSMS = Perceived Diabetes Self-Management Scale.*

diabetes control after adjustment for age, sex and duration of diabetes when compared with those with lower PDSMS scores. Male subjects also had a higher probability (OR = 19.80, 95% CI = 1.34–291.93) of reaching the target diabetes control after controlling for age, duration of diabetes, and PDSMS scores (Table 4).

Discussion

To the best of our knowledge, this is the first study in Taiwan to explore the relationship between self-efficacy and target HbA1c level in adolescents with type 1 DM. Our results were compatible with other studies that have shown that high self-efficacy is related to good metabolic control.[20,21] Considering the suffering of long-term complications caused by poorly controlled diabetes, our study sheds light on a possible strategy to improve quality of care.

There are no universally adopted criteria for the age limit of adolescents. Participants in our study ranged from 12 to 20 years of age, which was similar to the definition of the American Society for Adolescent Medicine (13–21 years of age). During this period in Taiwan, adolescents are attending high school and up to the first 2 years of college. For adolescents with type 1 DM, it is necessary to shift gradually the tasks of insulin injection and blood sugar monitoring from their parents to themselves. Their adaptation to this change might play a crucial role in their long-term well-being and living with chronic disease. Thus, it is important to study the drive to achieve good metabolic control at this important period of adolescence.

With regard to our correlation analysis, age correlated well with duration of diabetes. HbA1c level did not correlate significantly with age or duration of diabetes, and this agreed with other studies.[22,23] PDSMS scores showed a negative correlation with duration of diabetes in our study, which implied worse self-efficacy after fighting diabetes for many years. However, by multivariate logistic regression, PDSMS scores, but not duration of diabetes, were shown to be important in reaching target HbA1c level. The association between PDSMS scores and duration of diabetes was not statistically significant in the study of Wallston et al,[15] which might have been caused by the mixture of type 1 ($n = 57$; 14.3%) and type 2 ($n = 341$; 85.7%) diabetic patients. Regarding blood sugar, Wallston et al used average blood glucose meter readings (a subset of 164 patients) in contrast to our single preprandial blood glucose test. Considering the daily fluctuation of blood glucose, PDSMS scores were correlated with blood sugar level in the study of Wallston et al ($r = -0.32$, $p < 0.001$) but not in our study. Most importantly, PDSMS scores showed a negative correlation with HbA1c level in both studies, which demonstrated that better self-efficacy (higher PDSMS scores) was indeed associated with better glycemic control (lower HbA1c level).

Many studies have focused on the relationship between self-efficacy and metabolic control of type 1 DM. Grossman et al studied self-efficacy in a sample of 68 adolescents with type 1 DM and a mean age of around 13 years. They found that girls had a significant positive correlation between their self-efficacy and glycemic control, but boys did not.[20] Littlefield et al also claimed that self-efficacy was the best predictor of adherence behavior in 193 adolescents with type 1 DM.[21] However, controversy surrounds this issue. Rapley argued that after adjustment for age, sex and types of diabetes, the best predictors of metabolic control for type 1 DM were hardiness and psychosocial adjustment.[24] In contrast, self-efficacy and coping skills were not regarded as significant predictors in that study. Glasgow surveyed 93 type 1 DM patients in a predominantly adult community, and found no clear relationship between adherence and blood sugar control.[25] In Taiwan, Chang et al researched 72 adult patients with type 1 DM, and confirmed that patients with better self-efficacy tended to have better self-care.[26] However, that study was not mainly aimed at adolescents. Furthermore, it only used descriptive statistics and Pearson correlation analysis to present the findings, without taking HbA1c as the main outcome variable. In our study that focused on adolescents with type 1 DM, PDSMS scores were noted to have a negative correlation with HbA1c level. This finding concurs with the research of Iannotti et al, which also demonstrated a significant negative correlation between self-efficacy and HbA1c level in 95 type 1 DM patients aged 13–16 years.[8] The influence of self-efficacy in reaching target HbA1c level was confirmed in our multivariate logistic regression. To summarize, our study further supports the importance of self-efficacy in achieving target blood sugar control among type 1 DM adolescents.

Interestingly, boys had a greater probability of reaching target diabetes control than girls. In our demographic data (Table 1), boys had lower average HbA1c levels than girls had ($p = 0.06$ by Mann–Whitney *U* test). Higher HbA1c level has also been associated with girls with type 1 DM from Asia and the Western Pacific regions.[27] However, due to the wide range of 95% CI (1.34–291.93) in our study, more studies with a larger sample size are needed to confirm if lower HbA1c level in male subjects is related to greater success in metabolic control. Longitudinal studies are also needed to observe the role that complications play in maintaining self-efficacy.

Many personal behavioral factors, such as self-efficacy, behavioral intentions, and coping skills, are involved in adaptation to type 1 DM.[14] Grey et al proposed a stress-adaptation model to explain the adjustment to chronic disease in adolescents. In this model, pre-existing factors including age, sex and diabetes, along with individual differences including coping skills, family support, and self-efficacy, result in different levels of HbA1c control.[28] Johnston-Brooks further proposed that self-efficacy influences HbA1c level in adolescents with type 1 DM through the mechanism of self-care.[29] The problems of self-care[30] and non-adherence[31] are prevalent among Taiwanese children and adolescents with type 1 DM; therefore, it is important to provide them with adequate guidance. Medical personnel can design educational activities to enhance self-efficacy in patients with poor self-care and consequently poor diabetic control.

Some limitations in our study should be addressed. First, the sample size was limited (52 subjects), and all the subjects came from only one medical center. This might limit the generalizability of the result. Second, validation of our Chinese translation of PDSMS depended on expert validity only. Cultural differences might have affected the wording of the PDSMS items, and caused inaccurate responses. Third, this study was cross-sectional; therefore, we cannot be sure about the cause–effect relationship between self-efficacy and successful blood sugar control. Nevertheless, this study still gave us an opportunity to investigate the current confidence level of self-management among Taiwanese adolescents with type 1 DM.

In conclusion, this study discloses that adolescents with type 1 DM have a greater opportunity to reach target blood sugar levels if they have higher self-efficacy, although sex also seems to play a role. Our study suggests that, for reaching target diabetes control to minimize long-term complications, we should improve self-efficacy in adolescents with type 1 DM.

References

1. Daneman D. Type 1 diabetes. *Lancet* 2006;367:847–58.
2. The Diabetes Control and Complications Trial Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 1993; 329:977–86.
3. Grey M, Cameron ME, Thurber FW. Coping and adaptation in children with diabetes. *Nurs Res* 1991;40:144–9.
4. Jacobson AM, Hauser ST, Wolfsdorf JI, et al. Psychologic predictors of compliance in children with recent onset of diabetes mellitus. *J Pediatr* 1987;110:805–11.
5. Tseng CH. Incidence of type 1 diabetes mellitus in children aged 0–14 years during 1992–1996 in Taiwan. *Acta Paediatr* 2008;97:392–3.
6. Diamond Project Group. Incidence and trends of childhood type 1 diabetes worldwide 1990–1999. *Diabet Med* 2006;23:857–66.
7. Lo FS, Yang MH, Chang LY, et al. Clinical features of type 1 diabetic children at initial diagnosis. *Acta Paediatr Taiwan* 2004;45:218–23.
8. Iannotti RJ, Schneider S, Nansel TR, et al. Self-efficacy, outcome expectations, and diabetes self-management in adolescents with type 1 diabetes. *J Dev Behav Pediatr* 2006;27:98–105.
9. Chaney JM, Mullins LL, Frank RG, et al. Transactional patterns of child, mother, and father adjustment in insulin-dependent diabetes mellitus: a prospective study. *J Pediatr Psychol* 1997;22:229–44.
10. Grey M, Davidson M, Boland EA, et al. Clinical and psychosocial factors associated with achievement of treatment goals in adolescents with diabetes mellitus. *J Adolesc Health* 2001;28:377–85.
11. Bandura A. *Self Efficacy: The Exercise of Control*. New York: WH Freeman, 1997.
12. Holden G, Moncher MS, Schinke SP, et al. Self-efficacy of children and adolescents: a meta-analysis. *Psychol Rep* 1990;66:1044–6.
13. Rose M, Fliege H, Hildebrandt M, et al. The network of psychological variables in patients with diabetes and their importance for quality of life and metabolic control. *Diabetes Care* 2002;25:35–42.
14. Glasgow RE, Fisher EB, Anderson BJ, et al. Behavioral science in diabetes. Contributions and opportunities. *Diabetes Care* 1999;22:832–43.
15. Wallston KA, Rothman RL, Cherrington A. Psychometric properties of the Perceived Diabetes Self-Management Scale (PDSMS). *J Behav Med* 2007;30:395–401.
16. Nathan DM, Singer DE, Hurxthal K, et al. The clinical information value of the glycosylated hemoglobin assay. *N Engl J Med* 1984;310:341–6.
17. Writing Team for the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group. Effect of intensive therapy on the microvascular complications of type 1 diabetes mellitus. *JAMA* 2002;287:2563–69.
18. Silverstein J, Klingensmith G, Copeland K, et al. Care of children and adolescents with type 1 diabetes mellitus: a statement of the American Diabetes Association. *Diabetes Care* 2005;28:186–212.
19. American Diabetes Association. Standards of medical care in diabetes–2009. *Diabetes Care* 2009;32(Suppl 1):S13–61.

20. Grossman HY, Brink S, Hauser ST, et al. Self-efficacy in adolescent girls and boys with insulin-dependent diabetes mellitus. *Diabetes Care* 1987;10:324–9.
21. Littlefield CH, Craven JL, Rodin GM, et al. Relationship of self-efficacy and binging to adherence to diabetes regimen among adolescents. *Diabetes Care* 1992;15:90–4.
22. Grey M, Boland EA, Yu C, et al. Personal and family factors associated with quality of life in adolescents with diabetes. *Diabetes Care* 1998;21:909–14.
23. Pinar R, Arslanoglu I, Isgüven P, et al. Self-efficacy and its interrelation with family environment and metabolic control in Turkish adolescents with type 1 diabetes. *Pediatr Diabetes* 2003;4:168–73.
24. Rapley P. Adapting to diabetes: metabolic control and psychosocial variables. *Aust J Adv Nurs* 1990;8:41–7.
25. Glasgow RE, McCaul KD, Schafer LC. Self-care behaviors and glycemic control in type I diabetes. *J Chronic Dis* 1987;40:399–412.
26. Chang FT, Lin CC. Using self-efficacy in assessing self-care to the IDDM patients. *Kaohsiung J Med Sci* 1997;13:351–9.
27. Craig ME, Jones TW, Silink M, et al. Diabetes care, glycemic control, and complications in children with type 1 diabetes from Asia and the Western Pacific Region. *J Diabetes Complications* 2007;21:280–7.
28. Grey M, Thurber FW. Adaptation to chronic illness in childhood: diabetes mellitus. *J Pediatr Nurs* 1991;6:302–9.
29. Johnston-Brooks CH, Lewis MA, Garg S. Self-efficacy impacts self-care and HbA1c in young adults with Type I diabetes. *Psychosom Med* 2002;64:43–51.
30. Chien SC, Larson E, Nakamura N, et al. Self-care problems of adolescents with type 1 diabetes in southern Taiwan. *J Pediatr Nurs* 2007;22:404–9.
31. Chang CW, Yeh CH, Lo FS, et al. Adherence behaviours in Taiwanese children and adolescents with type 1 diabetes mellitus. *J Clin Nurs* 2007;16:207–14.